COGENERATION

Opportunities in Today's Power Markets

R. W. Meidel, Vice-President-Power Projects
ExxonMobil Power and Gas Services Inc

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Presentation Outline

- Cogeneration at ExxonMobil
- Investment Considerations
  - Opportunity Identification
  - Opportunity Optimization
  - Opportunity Assessment
- Enabling Power Market Structures

Why Cogeneration?

ECONOMIC

ENERGY EFFICIENT

LOWER EMISSIONS

SUPPLY SECURITY

Singapore POX / Cogen
155 MW Total Capacity

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Background

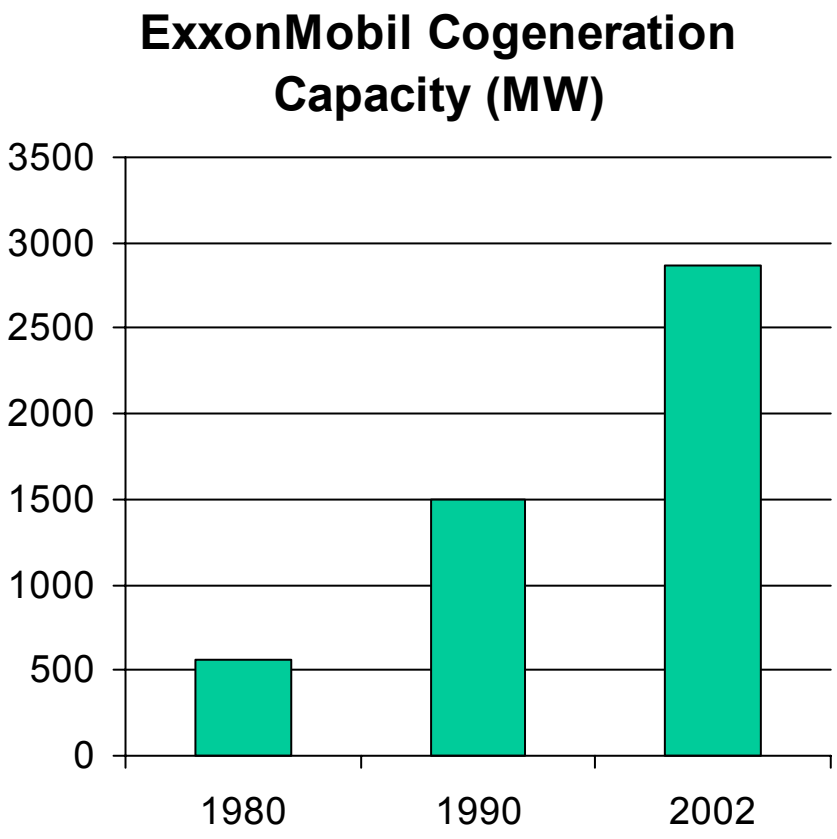
- Traditional practice:
  - Burn fuel - via boilers - to generate steam
  - Purchase electricity
- Conventional power generation produces substantial waste heat
  - Increased consumption of energy resources
  - Higher costs
  - Greater emissions of CO_2, NO_x, SO_x

Baytown, Texas, USA
407 MW Total Capacity

- Cogeneration is an attractive alternative
  - Generate power and convert waste heat to steam
  - Efficiency can be twice as high as thermal power generation
  - Fueled with natural gas, CO_2 emissions lower still

ExxonMobil: A Leader in Cogeneration

- Nearly 2,900 MW of installed cogeneration capacity; first installation in 1950
- Cogeneration met ~ 70 % of global refining / chemical plant electricity needs in 2001
- Worldwide annual energy savings equate to more than 25% of the total generated by all solar and wind facilities worldwide
- CO_2 emissions reduced ~ 7 million tons / year
- Projects under development / construction increase cogeneration capacity 35+%



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Cogeneration Investment Considerations

- Opportunity Identification
  - Site Requirements
  - Fuel Considerations
    - + ExxonMobil's Patented Gas Utilization Technology
  - Existing Electricity Suppliers & Tariffs
  - Other Operating or Economic Considerations
- Technology Selection
- Opportunity Optimization

Baton Rouge, Louisiana, USA
445 MW Total Capacity

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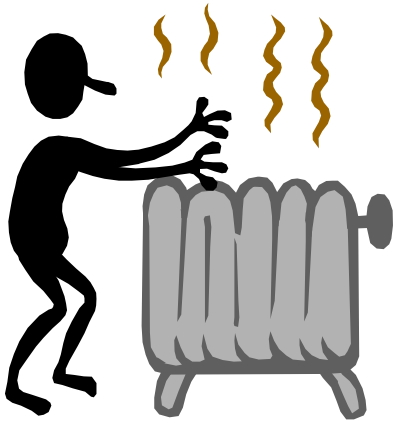
Site Requirements

- First consider steps to optimize existing operations with minimal investment

- Identify site steam and power requirements
  - Normal requirements
  - Infrequent or unusual requirements
  - Future expansions and impact on requirements
  - Seasonality
  - Reliability / operating cushion
  - Backup



Cogen Fuel

- Evaluate produced versus purchased fuel
- Produced fuel includes refinery fuel gas, petroleum coke, by-products, etc; Considerations:
  - Normal production levels
  - Fuel quality variability; Potential for abnormal variation
  - Seasonality
  - Cost (net of credits such as cost avoidance of waste fuel disposal)
- Availability and specifications of purchased fuel
- Fuel switching opportunities
  - Substitution / Blending
- Low quality fuel may be suitable for power generation

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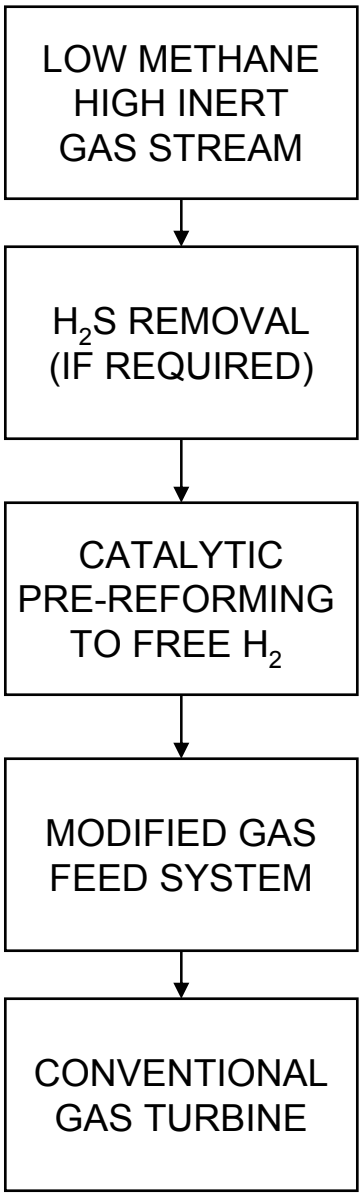
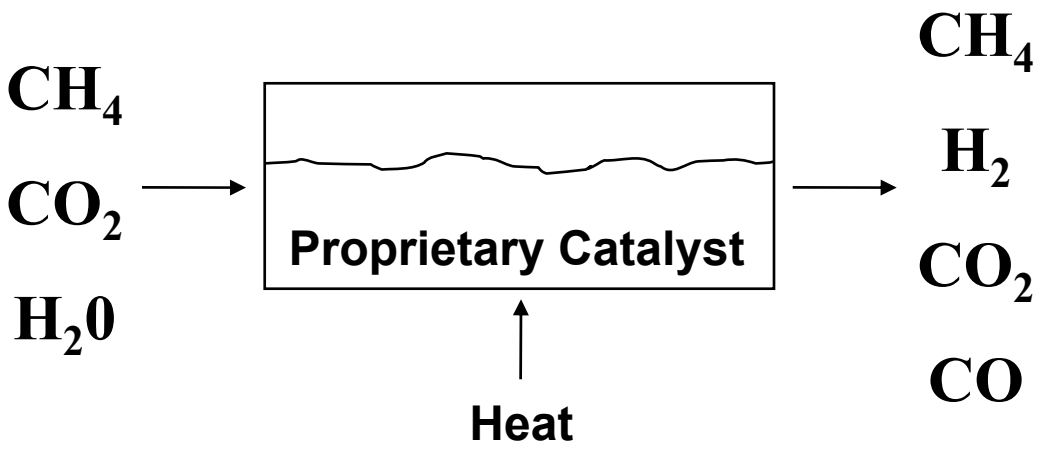
ExxonMobil Patented Technology



- ExxonMobil's low BTU gas utilization technology transforms low methane, high inert gas into gas turbine fuel containing an increased fraction of hydrogen gas
- Hydrogen is liberated from the fuel gas stream using a commercially proven catalytic process



Major Reactions:

$$CH_4 + 2H_20 \text{ <-----> } 4H_2 + CO_2$$
$$CH_4 + H_20 \text{ <-----> } 3H_2 + CO$$
$$CH_4 + CO_2 \text{ <-----> } 2H_2 + 2CO$$

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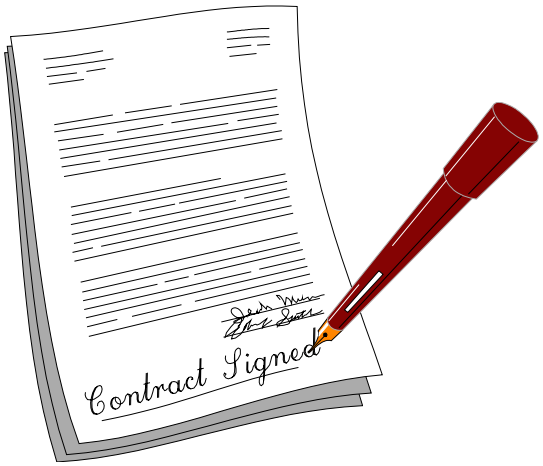
Electricity Tariffs & Service Contracts

- Understand economic impact of existing agreements
  - Cogeneration may reduce / eliminate grid related charges
  - Offtake provisions / commercial incentives provided by regulations
- Consider existing power purchase terms
  - Demand charges, energy charges, connection charges, etc
  - Pricing for firm versus varying degrees of interruptible supply
- Previous long-term commitments may limit flexibility to consider internal power generation
  - Consider renegotiating or buying-out of existing commitments



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Other Operating / Economic Considerations

Potential Incentives / Opportunities

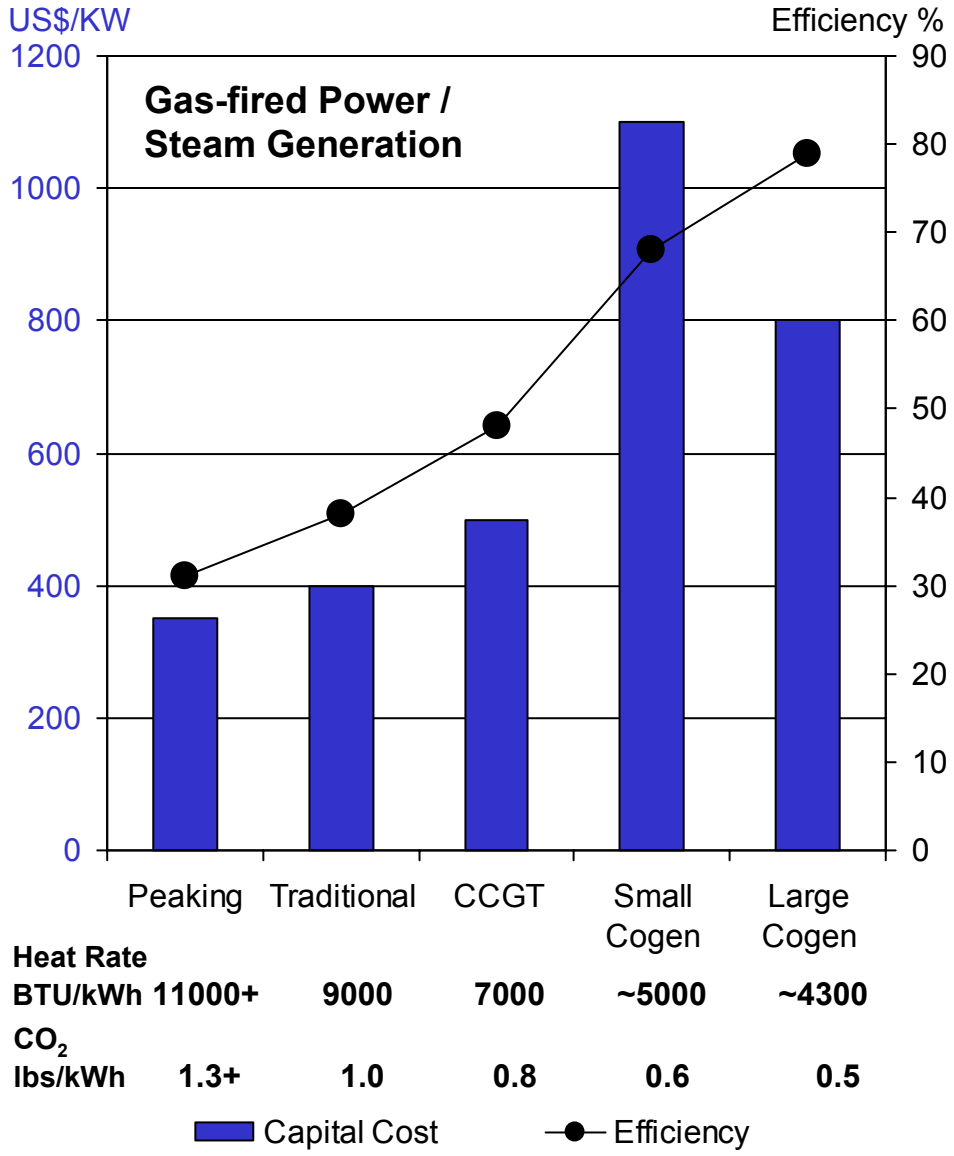
- Investment / cost avoidance
  - Equipment upgrades
  - Environmental retrofits
  - Disposal of by-products used as fuel
- Optimize production process
  - Economic production of by-products
  - Efficient use of refinery gas
- Spare power capacity of existing tie-ins to power grid

Potential Disincentives / Constraints

- Emissions implications of fuel choice
  - Pollution control equipment
  - Investment cost versus alternative fuel cost
- Physical space constraints
- Availability of quality cooling water
- Investment to increase fuel gas pressure if high-pressure gas not available

Whether or not a mismatch between power and steam generation is a constraint or an opportunity depends on the commercial environment

Technology Selection



- Matching site power demand may not take full advantage of available steam sink
  - Capture cost savings available from larger, more efficient units
- Trade-offs between capital investment, operating costs and risk (e.g. power sales price and dispatch risk) for each technology choice
- Evalute alternatives
  - Boiler/steam turbine (gas, liquids, solids)
  - CCGT
  - Gasification

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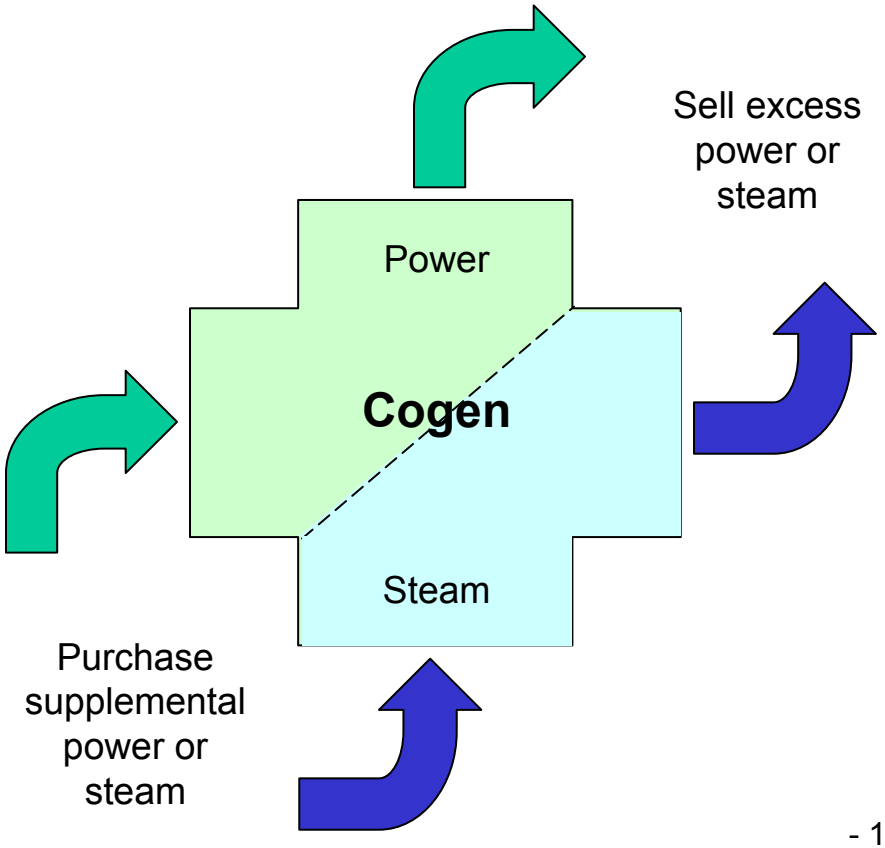
Opportunity Optimization

- Design cogeneration capacity to optimize integrated economics at acceptable risk
  - Adjacent facilities may comprise a single site



- First pass: Cogen opportunity covers base-load steam needs
- Next pass: What power output optimizes integrated project return?
- Optimum facility may be one with multiple channels for power / steam sourcing and use
- Flexible outlets for sale of excess power or steam / heat generation
- Options for sourcing additional power or steam to augment internal generation
- Ancillary sales opportunities

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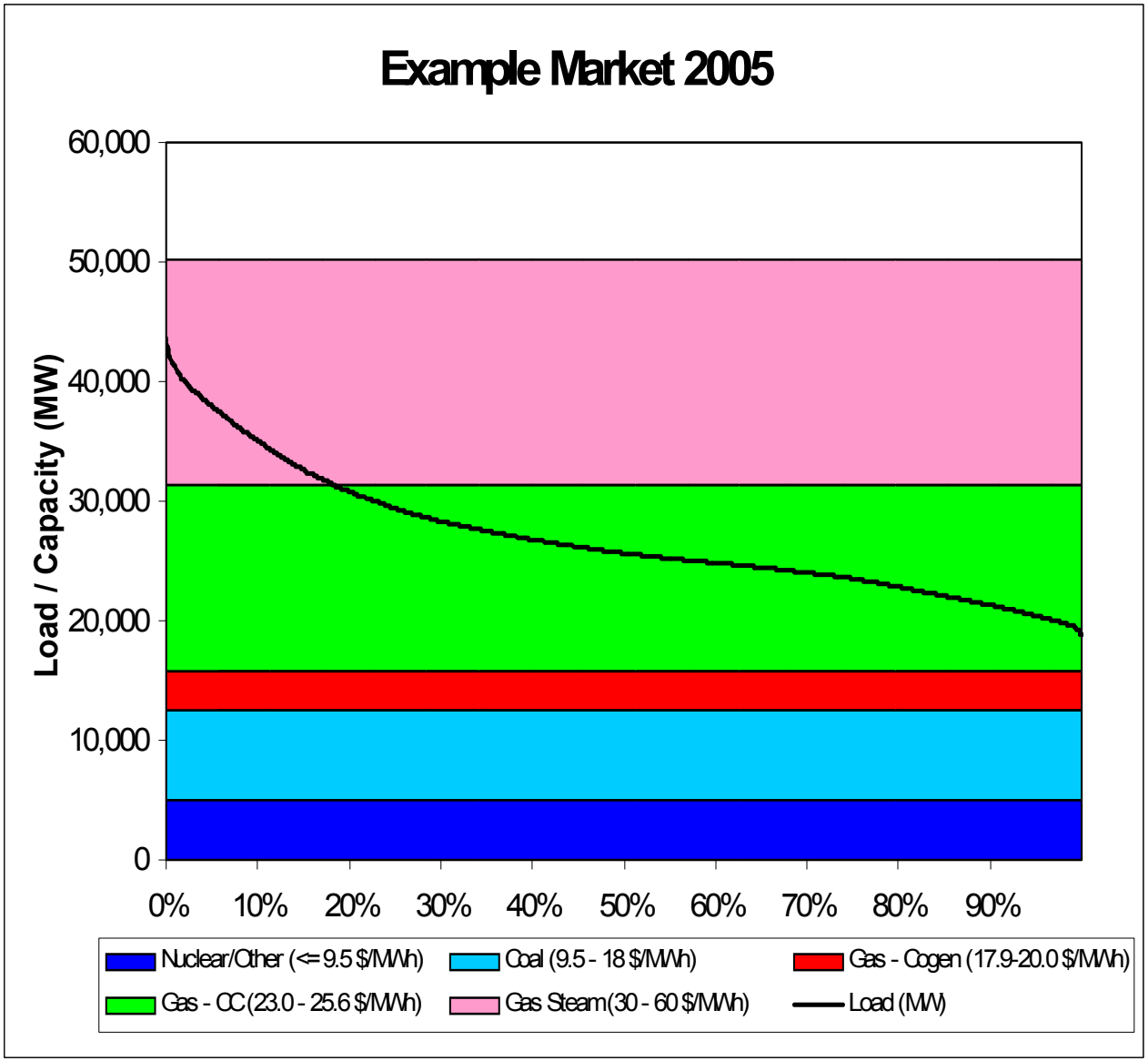
Opportunity / Market Assessment



- Load duration curve (demand) versus dispatch rank
- Assumes plant with lowest marginal cost runs the most hours
- Cogen plants typically "must run" due to steam requirements
  - Serves base-load demand
- Power bid to ensure dispatch

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Enabling Power Market Structures

- Rational dispatch
  - No artificial separation of steam / power as discrete products; Cannot be made separately; Integral to site operations
  - Cogenerators allowed to purchase net requirements or sell potential excess without discrimination
- Use-based transmission / market / ancillary charges
  - Charges based on actual use to support **net** internal load
- Flexibility around market participation / compliance costs
  - Cogenerators may buy services from third parties (e.g. reserve capacity)
  - Alternatives for direct sales, or indirect sale via bilateral contract with market participant

Conclusion

- Cogeneration
  - Increases steam reliability
  - Enhances cost competitiveness of products; directionally higher dispatch rates
  - Can reduces demand for purchased fuels
  - Reduces emissions per unit of electricity generated
- Power market rules should encourage opportunities for both industry and the public to realize the benefits of cogeneration